THE ORIGINS AND PRINCIPLES OF THE WORLD DATA CENTER SYSTEM

F.L. Korsmo

National Science Foundation, Office of the Director, 4201 Wilson Boulevard, Arlington, VA 22230, USA Email: <u>fkorsmo@nsf.gov</u>

ABSTRACT

Archival research shows that the designers of the International Geophysical Year intended the World Data Centers to allow full and open access to scientific workers while respecting the right of individual investigators to publish results. World Data Centers A, B, and C were formulated to cover the United States, the Soviet Union, Europe, and Asia with multiple copies of datasets to ensure against catastrophic destruction of data and offer multiple access points to researchers and students.

Keywords: Data, Archive, IGY, World Data Center, WDC, Geophysics

1 INTRODUCTION

The International Geophysical Year (IGY) was a worldwide effort to study the earth, oceans, and atmosphere in a coordinated, synchronous way. The World Data Centers are among its most important legacies. The IGY was predicated on full and open data exchange. Several IGY planners saw the IGY as a means to loosen up Cold War secrecy and demilitarize geophysics. The World Data Center System was governed by the principle of equitable access: the data should be readily available for use by all qualified scientists. Then, as now, new technology contributed to the speed at which data could be collected, processed, and distributed. Then, as now, questions arose surrounding the role of the data centers in satisfying interdisciplinary versus disciplinary needs, the sustainability of the centers over time, and the responsibilities of centers in relation to individual researchers. This overview of the origins and principles of the World Data Center system is intended to provide a historical background for the current discussions among national and international scientific bodies on the future of data and information services. While the emphasis here is on the discussions and controversies that took place in the United States, the issues of scientific cooperation and full and open access to scientific data transcended national boundaries then as they do today.

2 ORIGINS OF THE IGY

Most sources place the beginning of the IGY at the home of Dr. James Van Allen, in Silver Spring, Maryland, in April 1950 (Sullivan, 1961; Van Allen, 1997 and 1998). Trained as a nuclear physicist, Van Allen was well known for his role in the development of the proximity fuze during World War II. He became involved in the use of rockets to study the upper atmosphere immediately following the war, instrumenting captured and refurbished German V-2 rockets to study cosmic radiation, the ionosphere, and geomagnetism. At the time of Chapman's visit, Van Allen headed up a high-altitude research group at Johns Hopkins University, Applied Physics Lab. Shortly thereafter, Van Allen went to the University of Iowa, where he would spend most of his professional career as a professor of physics (American Institute of Physics, 2000). While in Maryland, he and his wife Abigail hosted a dinner on 5 April 1950 for British geophysicist Sydney Chapman. Chapman, a theoretical physicist interested in the earth's magnetic phenomena, had participated in the Second Polar Year of 1932-1933. He was known for his work on magnetic storms and would come to spend a great deal of time in the United States, at the University of Alaska Fairbanks, the High Altitude Observatory in Boulder, Colorado, and University of Michigan (Good, 2000). In April 1950, Chapman was in the United States on his way to join a Caltech study on the upper atmosphere. Van Allen described the gathering as "one of the most felicitous and inspiring" that he had ever experienced. Also present at the dinner was Lloyd Berkner, a former radio engineer who had been on Admiral Byrd's 1928-1930 Antarctic expedition. Berkner had both science and policy in his background (Needell, 2000). According to Van Allen, the dinner conversation ranged widely over geophysics and especially geomagnetism and ionospheric physics. Following

dinner, as they were all sipping brandy in the living room, Berkner turned to Chapman and said, "Sydney, don't you think that it is about time for another international polar year?" Chapman immediately embraced the suggestion, remarking that he had been thinking along the same lines himself (Van Allen, 1998).

Chapman also observed that the years 1957–1958 would be a time of maximum solar activity, so the time frame for the Third Polar Year was settled. The properties of the upper atmosphere, including the relationships among magnetic storms, cosmic rays, and solar activity intrigued scientists. The military, in particular, was interested in very-high-frequency scatter technology for reliable low-capacity communication that could avoid the disruptions caused by solar emissions, magnetic storms, and auroras. The perturbations emanated from high latitudes. Choosing a year of maximum solar activity for a new international polar venture made scientific sense for atmospheric physicists interested in understanding more about these high-latitude phenomena. Furthermore, as Chapman explained later (1960) and may well have noted at the Van Allen residence, technological improvements in instrumentation and rocketry enabled scientists to probe much deeper into the atmosphere.

How did the Third Polar Year, originally envisioned as a high-latitude, upper-atmosphere research campaign, become the International Geophysical Year? In the process of enlisting support among the international scientific societies, Chapman and Berkner found a strong preference for a global program encompassing additional geographical regions and physical science disciplines. To attain this widespread support, Chapman and Berkner embraced a much broader geophysical agenda than they originally planned.

The international science scene after World War II included a reconstituted International Council of Scientific Unions (ICSU), a body where membership was both by nation-state and by international scientific union, e.g., the International Union of Geodesy and Geophysics (IUGG). The national member might be a national academy or a government agency with research responsibilities. Berkner and Chapman first presented the idea for the Third International Polar Year to the constituent scientific unions that made up a "Mixed Commission on the Ionosphere" under ICSU (Beynon, 1975). These unions included the IUGG, International Astronomy Union (IAU), International Union of Pure and Applied Physics (IUPAP), and International Union of Radio Science (URSI) (Beynon, 1975). The unions, in turn, presented the proposal to the ICSU General Assembly, and ICSU, in turn, invited the World Meteorological Organization (WMO) to participate as well as the national organizations adhering to ICSU. In the process of extending the idea to the different organizations, it became clear that the whole surface of the earth, not just the polar regions, were of great interest (Jones, 1959). Once the adherence of the WMO and the various scientific union members of ICSU were obtained, the ICSU Bureau suggested that individual countries form national committees (The approach to the U.S.S.R. Academy of Sciences was made through WMO since the U.S.S.R. did not belong to ICSU.). By late 1953, there were 26 countries signed up to participate in what Chapman suggested as the more encompassing "International Geophysical Year" of 1957-1958. The disciplines included practically all the earth, atmosphere, and oceanic sciences, covering many parts of the globe beyond the polar regions (Nicolet, 1984).

The U.S. National Academy of Sciences assembled its IGY Committee for a first meeting in early 1953. Thirteen other countries already had functioning IGY Committees by this time, according to Berkner, and others were waiting to see what the United States was prepared to do (Gerson, 1953). Some U.S. scientists simply were not interested. The oceanographers, for example, did not respond initially with any enthusiasm to the Academy's invitation (U.S. National Committee for the IGY, 1952, 1953). However, Berkner brought a sense of urgency to the Committee. He could not be present on the first day of the two-day meeting, and thus the participants were free to express their doubts. They saw at least two related problems: one, the question of whether the Soviet Union would participate and two, the secrecy and classification of geophysical data that existed at home in the United States.

How could you have a worldwide program when the Soviet Union and its allies were not involved? The Soviet Union was a member of the WMO and the International Astronomical Union, but not ICSU or the other ICSU member unions. There was hardly any data exchange with the East except for routine weather observations. On the other hand, the United States also classified much of its data; the entire polar program funded by the military, for example. How could the Americans expect the Soviet scientists to supply data when so much of the American data were not available? All high-latitude ionospheric data – the original focus of the Third Polar Year as proposed by Berkner and Chapman – were considered classified in the United States (Gerson, 1953).

It is instructive to review the minutes of these early IGY meetings that took place in Washington, DC in 1953. According to the detailed notes taken by the Executive Secretary, Nate Gerson, skepticism and frustration on the part of some committee members (e.g., Merle Tuve) battled with optimism and a sense of urgency on the part of others (e.g., Berkner). The world is watching us, Berkner seemed to say. We must go forward, and it is likely that the Soviet Union will join us (Stalin died only days before the meeting, and there was hope for change). We must proceed on the basis of open, non-military science and full access to the resulting data, said Berkner. The IGY would be a way to loosen up the secrecy classifications at home and improve the data flow from other countries. In addition, the data would also be valuable in the future, long after the IGY came to a close. As Berkner told the members of the U.S. National IGY Committee at their first meeting, "Presumably there will be a 4th Geophysical Year. Let our measurements be designed so that repeats during the 4th will be valuable." This was farsighted indeed. Tuve was absent on the second day of the meeting, and Berkner's view held sway.

By late 1954, the Soviet Union clearly signaled its intent to participate in the IGY, and the international IGY organizing committee (set up by ICSU in 1952 and known as CSAGI after its French name, Comité Spécial de l'Année Géophysique Internationale) established the criteria for IGY proposals. Priority would be given to projects with at least one of the following characteristics:

--Problems requiring concurrent synoptic observations at many points involving cooperative observations by many nations.

--Problems in geophysical sciences whose solutions would be aided by the availability of synoptic or other concentrated work during the IGY.

--Observations of all major geophysical phenomena in relatively inaccessible regions of the Earth that can be occupied during the IGY because of the extraordinary effort during that interval (the Arctic and Antarctic).

--Epochal observations of slowly varying terrestrial phenomena (Jones, 1959).

These criteria permitted a variety of disciplines and conformed in the main with the justification for a coordinated program confined to an 18-month time period, from July 1957 through December 1958. Each discipline fitting the criteria had a technical committee with a "reporter" (more akin to the French *rapporteur* than a scribe or journalist) whose responsibilities included working with the appropriate scientific union to organize the program for that discipline. The program for each discipline was first outlined by an IGY Committee created by the appropriate scientific union or by some other ICSU body. Detailed coordination of the program, such as the issuance of instruction manuals for the taking of measurements, was the responsibility of the reporter and the technical committee covering that discipline or topical area. The overall direction was the responsibility of the CSAGI Bureau (Bullis, 1973; Nicolet, 1984).

The CSAGI Bureau members, reporters, and members of the CSAGI General Assembly all served based on their scientific field and their professional standing in the ICSU unions rather than based on nationality. Representation on the basis of science rather than nationality enabled CSAGI and the committees to focus on the nature of the work to be done rather than which nation would be responsible for which projects. Not surprisingly, Chapman and Berkner emerged as the leaders of IGY (Chapman was elected President and Berkner Vice-President of CSAGI).

3 THE DEVELOPMENT OF WORLD DATA CENTERS

From the earliest stages of organizing the IGY, the CSAGI considered what to do about data. After all, with synchronous measurements being taken at many observing stations, the data would be flowing from all parts of the world and needed to be standardized to create a coherent picture of global phenomena (Jones, 1959). At its decisive meeting in Brussels in 1955, when the Soviet Union officially unveiled its IGY programs, CSAGI set up a special Committee on the Availability of Data. This Committee recommended that data centers be set up in different countries as depositories and dissemination points for IGY data. The data would be collected and made available to any scientists without condition except for the cost of reproduction and mailing. The Committee recommended that CSAGI publish guides to the depositories and the types of data available from each. These World Data Centers would be more than passive depositories. They would actively supply data and provide the necessary facilities for data analysis. Two of the participating national IGY committees, the U.S. and the U.S.S.R., each offered to establish and maintain collections of all the IGY data (not necessarily all in the same place). These two data centers would be

known as A and B, respectively, and other participating committees, as well as the World Meteorological Organization (WMO), offered to set up partial data collections. Collectively the latter became known as World Data Center C. (CSAGI Guide to IGY World Data Centers, 1959).

In the U.S., considerations of how to organize World Data Center A went hand in hand with how to conduct the IGY scientific program and the future of geophysics in the country. What would be the role of the computers and data technology that emerged from World War II? How automated could you make the observation techniques, the data collection and analysis? After all, data could now be generated and read in machine-readable formats (Ruttenberg & Rishbeth, 1994). However, this capacity varied among the IGY disciplines, and it seemed best to leave the question of automation to the technical committees and working groups affiliated with those disciplines. On the other hand, neither Chapman nor Berkner could resist the opportunity to influence future directions in an increasingly data-driven enterprise. This was an era of institution building in North America, and the tasks of data collection, reduction, and analysis could not be separated from developing a cadre of researchers (England, 1980).

Chapman, who chaired the special Committee on the Availability of Data, had the concept of a world data center in mind well before the 1955 Brussels meeting of CSAGI, but he was focusing on the aurora. In January of that year, Chapman, in his capacity as President of CSAGI, wrote to Merle Tuve, Director of the Department of Terrestrial Magnetism (DTM) at the Carnegie Institution of Washington, and asked him if the DTM would be willing to undertake the central reduction and analysis of the IGY auroral data (Chapman, 1955a). Tuve declined the opportunity, noting that he had no interest in making the DTM a large administrative agency, but instead a home for nurturing the independence and freedom of individual researchers. Both Tuve and his associate, E.H. (Harry) Vestine, thought that the analysis of the auroral observations by themselves would be "rather sterile," and instead urged a more integrative world data concept that would include a great variety of information, including ionospheric, auroral, and magnetic data (Tuve, 1955). Chapman accordingly encouraged the U.S. National Science Foundation in February 1955 to think about geomagnetism on a large scale, on land, in the oceans and atmosphere, combining observations, instrumentation, methods, and data reduction and interpretation (Chapman 1955b).

Berkner also approached the National Science Foundation about the need for a national geophysical institute to obtain and analyze the "torrents of raw data" that would flow during the IGY (England, 1983). So by late 1954, both Chapman and Berkner had accepted the need for a large data-gathering push, but the question became how to deal responsibly with the data. What organizations were capable on the US side, if not the DTM?

In late 1955, after making a commitment to host a World Data Center, the U.S. National Committee for the IGY established an ad hoc World Data Center Committee to make a preliminary study of whether it should be a unified center or several centers for different disciplines, how much the effort would cost, and how it might be related to the proposed Institute for Theoretical Geophysics that Berkner had proposed earlier to the NSF (Kaplan, 1955).

E.H. ("Harry") Vestine chaired the World Data Center Committee. Vestine was also on the ad hoc NSF committee to develop the groundwork for the proposed Institute for Theoretical Geophysics. The NSF committee, chaired by the famous mathematician John von Neumann (who had been recently appointed to the Atomic Energy Commission), was to organize a conference on the subject. Von Neumann became deathly ill, however, and much of the work fell to subcommittees, including a subcommittee on institute planning and a subcommittee on finance (Indeed, Neumann died of cancer in February 1957.). Vestine filled the gap by chairing the finance committee and getting the institute planning committee together (Vestine, 1955-1956; U.S. National Committee for IGY, 1954-1959).

Vestine was the connection between the separate but not unrelated quests for an institute of theoretical physics and an institute to house the world data center. Vestine and his colleague on the committee Gerhard Schilling traveled to several universities throughout the country to assess their interest and capabilities in hosting a world data center. It was not a coincidence that many of these same universities expressed an interest in an institute of theoretical geophysics, including University of California at Los Angeles, California Institute of Technology, and University of Colorado. The people who were poised to gather and analyze the IGY data wanted the data close-by (Vestine, 1955-1956).

Vestine's site visits, the NSF conference on the proposed institutes of theoretical geophysics, and interactions among CSAGI members such as Chapman and Berkner with individuals such as Harry Hess at Princeton and Walter

Roberts at the High Altitude Observatory in Colorado led to high expectations. Chapman favored University of Colorado for the institute, "because of its already good library (though capable of improvement), and the near presence of the Boulder NBS [National Bureau of Standards] laboratories and of the coronal observatories" (Chapman, 1955c). Walter Roberts had convinced Chapman to visit Boulder on a continuing basis, dividing his time between there and University of Alaska's geophysical institute. Berkner, on the other hand, looked to Princeton. As he wrote to Harry Hess, "Princeton is ideally located on the main street of the east coast. It has an impeccable reputation, and the kind of academic atmosphere we are looking for…it has fine faculties in the subjects related to geophysics, including engineering. It has easy access to the Institute of Advanced Studies and to the computer facilities in the neighborhood of Princeton" (Berkner, 1955).

Chapman and Berkner differed markedly in their goals for an institute. Chapman was mostly concerned about the fate of observatories and observations in a politically unstable and rapidly changing world. Berkner was more interested in advancing the capacity of U.S. geophysical research, particularly with regard to theoretical contributions.

Chapman, in his letters to Tuve and the National Science Foundation, described the monumental work done by Carnegie DTM in the early twentieth century – the great ocean and land magnetic surveys – and the latter work in ionospheric studies through Breit and Tuve and latter Berkner (Chapman, 1955a, 1955b). He also touched on the latter theoretical work by McNish and Vestine. On the retirement of Fleming, he noted with regret, the DTM disengaged itself from the standard survey and observatory programs. Other institutions have taken over; for example the National Bureau of Standards conducted ionospheric research and several universities also pursued this in addition to cosmic ray research. Chapman had no problem with the government agencies and universities engaging in basic research, but he did not want to lose sight of the need for continued support for <u>observations</u> and <u>observatories</u>. Chapman saw this as an opportunity for the United States to take the lead in an international effort. The problem, he wrote, was one of resources and capacity, particularly the need to build capacity <u>outside</u> of the U.S.:

In an ideal world, this important field of study, demanding extensive and continuing observational as well as interpretative effort, might be in the charge of an organ of the United Nations Organization. As things are, it seems to me that it can be satisfactorily dealt with only through the active leadership of this country, using its own men and means, and stimulating other countries to make the best contribution within their power. It requires money on a larger scale than envisaged hitherto, but in so far as this would include what might be called foreign aid – which seems indispensable, as observations are needed in countries unable or unprepared (as yet) to make them – it seems to me to be foreign aid of a fine and wise kind, probably befitting the giver at least as much as the receiver. How it should be organized and financed is a question of the greatest importance: good administration is needed along with good scientists and scientific means (Chapman, 1955b).

Berkner's vision was quite different (Berkner 1955). He and Vestine had conferred about a future geophysics institute. The United States, wrote Berkner on the basis of his discussion with Vestine, has excelled or at least contributed substantially in the measurement of geophysical quantities, e.g., for rocketry, ionosphere, geomagnetism, aurora, cosmic rays, meteorology, gravity, and seismology but has relied on Europeans and Asians for the illuminating interpretations. Americans have not been leaders in theory. For one thing, they have lacked a suitable place to work. Government laboratories have not encouraged theory. An institute would offer a place for theoretical work for Americans and foreign visitors, and it would "bring into more intimate relationship the several sciences of the Earth at the many points where they cross through common mechanism or processes." It would sharpen the Americans' experimental work from empiricism to theory.

Chapman seemed to have been talking about a permanent IGY, while Berkner wanted to strengthen geophysics training and research domestically in the United States. Neither was particularly concerned about the data per se but rather the advantages that the availability of data would confer on the progress of the science.

With regard to the proposed Institute of Theoretical Geophysics, NSF found itself responding positively – after the conference took place in early 1956 and after yet another committee reported its findings – to the Congressional mandate to establish a geophysical institute in Hawaii (England, 1983). However, this did not solve the World Data Center problem, and the US National IGY Committee continued to plan and budget for such a Center.

Berkner and Chapman both agreed on the desirability of having the data near a university. But they realized there was not a single university in the country with strengths in all the IGY disciplines. Already the idea of a single Institute of Theoretical Geophysics had whipped up competition among campuses. Alan Shapley, Vice Chairman of the U.S. National Committee, and in charge of developing and implementing the worldwide IGY alert system that would notify the observatories of major atmospheric events, worried that Vestine and Schilling had given the wrong impression on their site visits to these campuses and "inadvertently committed the USNC to specific arrangements which... would be impractical or embarrassing to change" (Shapley, 1956).

The site visits and draft report by Vestine and Schilling also gave the impression that the U.S. National Committee was planning to fund one center per IGY discipline (Vestine & Schilling, 1956). This alarmed the executive secretary, Nate Gerson, who may or may not have known that the USSR plan for data centers was at that point much more centralized than the free-for-all U.S. approach. Gerson pointed out the advantage of grouping related disciplines at a center, noting that the data center should play a fundamental role in fostering integration within geophysics, at least in three broad categories: electromagnetic, climate, and geodetic-geologic (Gerson, 1956).

Gerson's point was that you could not consider the polar ionosphere without considering the effects of the aurora, geomagnetism. and cosmic rays. Similarly, in climate studies, glaciology, oceanography, and meteorology all went together in an interdisciplinary fashion. Gerson suggested, accordingly, consolidating the repositories along the following lines:

- --Aurora, airglow, cosmic rays, geomagnetic, and ionospheric data
- --Glacial, hydrologic, meteorological, and oceanographic data
- --Aurora, cosmic ray, geomagnetic, and ionospheric data about 50 degrees North
- --An interim center for rocketry and earth satellite data (Gerson, 1956)

Instead, what Vestine and Schilling recommended, and the U.S. National Committee accepted, was a set of 12 primary data centers corresponding to the separate IGY disciplines, as shown in Table 1 (Vestine and Schilling, 1956).

Discipline	Institution	Location
Aurora I	University of Alaska	College, Alaska
Aurora II	Cornell University	Ithaca, New York
Airglow, Ionosphere	Central Radio Propagation Lab	Boulder, Colorado
Cosmic Rays	University of Minnesota	Minneapolis, MN
Earth Satellite	Smithsonian Astrophysical Observatory	Cambridge, Mass
Geomagnetism, Gravity, Seismology	U.S. Coast and Geodetic Survey	Washington, DC
Glaciology	American Geographical Society	New York, New York
Latitude and Longitude	U.S. Naval Observatory	Washington, DC
Meteorology	National Weather Records Center	Asheville, North Carolina
Oceanography	Texas A&M University	College Station, Texas
Rocketry	State University of Iowa	Iowa City, Iowa
Solar Activity	University of Colorado	Boulder, Colorado

Table 1. The Disciplines, Institutions, and Locations of World Data Center A

Some of these centers were linked with a single individual who, together with students or staff, was willing to undertake the job, e.g., Van Allen at Iowa, and William Field at the American Geographical Society. While Gerson's suggestions for interdisciplinary centers were not followed, there was significant communication among the Centers, and the seeds were sown for new interdisciplinary activities in the post IGY world.

In contrast to the highly distributed approach taken in the U.S., the U.S.S.R.'s proposed World Data Center was organized in terms of two subcenters:

B-1: Novosibirsk, Scientific Research Institute of Aeroclimatology, Head Department of the Hydrometeorological Service, Council of Ministers, USSR. B1 would collect data on meteorology, glaciology, oceanography, latitude and longitude, seismology, gravimetry, rockets and satellites, and meteors.

B-2: Moscow, Institute of Terrestrial Magnetism, Ionosphere and Radiowaves Propagation, Ministry of Intercommunications. B2 would collect data on geomagnetism and earth currents, ionosphere, solar activity, aurora and airglow, and cosmic rays (U.S. National Committee for the IGY, 1957).

The responsibilities of the world data centers were fairly hefty. It was one thing to name the centers that would make up World Data Center A; it was another to develop the contracts and work plans and then monitor their progress. In January 1957, when the U.S. National Committee accepted Vestine and Schilling's recommendations, IGY was six months away.

Hugh Odishaw, who worked closely with Alan Shapley to develop the fund-raising strategies and overall organization plan for U.S. participation in the IGY, apparently thought about recruiting an eminent scientist to lead the World Data Center effort. But, wisely, Vestine noted that "Hugh might be aiming too high in trying to think of people like Harry Wells. Don't you really now need a well-informed housekeeper..." (Vestine, 1956). Certainly much of the housekeeping went to the professional staff of the U.S National IGY Committee. These scientists and administrators made sure that the data were collected and made widely available. Shapley, Odishaw, Pembroke Hart, and Stanley Ruttenberg are names that come to mind (e.g., Hart, 1960).

On the international level, CSAGI recruited Vice Admiral Archibald Day as the World Data Center Coordinator. The design of the CSAGI Guide to the IGY World Data Centers was determined at a special meeting in Brussels in April 1957. The Guide outlined the responsibilities of the participating IGY committees, the World Data Centers, and the observing stations. In general, each Center was to make every effort to collect a complete set of data within the field or disciplines for which it was responsible, and each participating committee was to make sure that the scientific institutions conducting the investigations were providing the data to one or more Centers. Each Center was responsible for the safekeeping of the data; the correct copying and reproduction of the data, maintaining adequate standards of clarity and durability; supplying copies of the data to the other Centers for the discipline; and preparing catalogs of all data in its charge. All requests for material from scientific bodies or investigators were to be handled within three months, and the fee charged for the material could not exceed the cost of copying and postage (CSAGI Guide to World Data Centers, 1959).

At the April 1957 meeting, CSAGI recommended the formal establishment of the World Data Centers for the IGY, as shown below in Table 2.

Center	Discipline(s)	Locations
А	All disciplines	U.S.
В	All disciplines	U.S.S.R.
С	Geomagnetism	Denmark and Japan
С	Aurora	Sweden and the United Kingdom
С	Airglow	France and Japan
С	Ionosphere	Japan and the United Kingdom
С	Solar Activity	Australia, France, German Federal Republic, Italy, Switzerland, United Kingdom
С	Cosmic Rays	Japan and Sweden
С	Glaciology	United Kingdom
С	Nuclear Radiation	Japan and Sweden

Table 2. General Organization of the World Data Centers, April 1957

In addition, the WMO would be the Center for Meteorology, and France would host the Center for Seismology in Strasbourg.

4 THE POST-IGY EVALUATION

At its Moscow conference in August 1958, CSAGI endorsed the continuation of IGY observations during 1959 but requested that the flow of data to the Centers be accelerated. Especially problematic were the disciplines that depended on the exact locations of the artificial satellites, since no agreement could be reached between the US and the U.S.S.R. on sharing information about their orbits. It was the one disappointing feature of the IGY noted at the Moscow conference. In other respects, however, the data flowed and the World Data Centers were functioning as anticipated. Admiral Day, in his last directions to the World Data Centers (June 1959), wrote that the collection of data was slow in some disciplines, and that the Centers themselves needed to actively seek out missing data. He added that CSAGI had rejected the request of some disciplines, e.g., cosmic rays, to delay data transmission until after the investigators had published their papers. Instead, CSAGI urged that anyone using the data give credit and acknowledgement to the original investigators contributed the data (Day, 1959).

In the U.S., the question was whether the World Data Center activities should continue to be supported after the IGY and its follow-up International Geophysical Cooperation Year of 1959. To determine this, the US IGY Committee chartered an ad hoc group to assess World Data Center A. The assessment, completed in June 1960, found widespread enthusiasm for the World Data Center concept and recommended the continued data archiving and exchange with the other World Data Centers to complete the US obligations undertaken in IGY and the IGC-59 (U.S. National Committee for the IGY, 1960a).

The U.S. National Committee's executive committee held several discussions on whether to continue to support the World Data Centers. Odishaw was favorably disposed and reported that the Japanese became very interested in the data centers, started additional data centers, and planned a centralized data collection effort for the upper atmosphere, cosmic rays, and solar activity. The Russians felt the data centers were extremely valuable and helped to foster international scientific exchange (U.S. National Committee for the IGY, 1960b).

Shapley, who had chaired the ad hoc committee to assess the World Data Center A and saw the continuing need for coordination and fiscal support, understood that some of the data centers would phase out naturally for lack of interest on the part of the host or a more appropriate host would be found. (For example, Texas A & M would continue to serve as the data center only until the Navy's oceanography center was completed.) Further, Shapley seems to have anticipated that the data centers would become gateways rather than warehouses, somewhat akin to the modern concept of a web portal. Shapley went on to say,

Remember the IGY was a big data collecting binge, and it has been clear for a long time that when this IGY-IGC [IGC – International Geophysical Cooperation, 1959, the successor year to IGY] was over, the emphasis on data collection per se and passing around of data would diminish, both because of exhaustion of the people and because it wasn't necessary to interchange data in such detail indefinitely...Secondly, I foresee that the role of the data centers will gradually shift to being more of an indexing of what data exists....Then, finally, I would say that through the mechanism of the data centers we have developed an awful lot of international contacts just in the correspondence of sending data and asking questions about it (U.S. National Committee for the IGY, 1960b).

Merle Tuve, ever skeptical of creating large top-heavy organizations, and the defender of the individual investigator and small groups of researchers, was clearly a convert to the World Data Center system put into place during the IGY. He phrased it quite dramatically, no doubt thinking of some of the more politically troubled countries he had encountered during the IGY:

I regard it as very important to continue the data exchange for observations even after IGC-1959. This is not motivated by advantages to be gained by USA, Russia, and other great depositories by the simple acquisition of more information. It is motivated, in my view, by the sense of mutual encouragement and support to scientific groups everywhere, especially in the smaller countries, which comes from the fact that world opinion esteems their efforts sufficiently to treasure the data they obtain. If in more of the world's affairs, this sense of mutual esteem could be engendered and sustained, there would be less necessity of tear-gassing our officials or putting other officials in jail (U.S. National Committee for the IGY, 1960a, Appendix VI).

While Tuve and Berkner disagreed on many things throughout their planning and carrying out of the US IGY program, they did agree on the universalism of science. The data centers, to them, embodied that principle. As Pembroke Hart repeatedly remarked in conversations with the author, "If you could get yourself to the door of the data center, you could not be denied access." This in itself is an important legacy of the IGY.

5 CONCLUSION

The designers of the IGY saw the need for full and open access to the data produced through the process of participatory, civilian (as opposed to military) science. They relied on the principles of access and reciprocity, while keeping in mind the integration of on-the-ground observations with scientific theory. Many of their discussions, reflected in archival documents and in recollections from oral histories, anticipate similar issues we face today. These include the rights and responsibilities of individual investigators, the resources needed for data sharing, the challenges of working across disciplinary and geographic boundaries, and the gap between the ideal – an institute of theoretical geophysics, a permanent IGY – and the pragmatic need to accomplish short-term results.

The notions of scientific data as a public good and geophysical research as a tool for sustainability have undergirded the present International Years. Careful attention to data and publication not only facilitates collaborative research and scientific exchange (the diffusion of knowledge across space), but also allows researchers to focus on future generations (the growth and development of knowledge through time). Today we have the means of instant publication and real-time data access, yet there is still a need to design rules and reinforce behavioral norms to maximize cooperation. The International Symposium, "Fifty Years after IGY," has made an outstanding contribution toward this end.

6 ACKNOWLEDGEMENTS

The author wishes to thank the National Science Foundation for its support of the research. This material was based on work supported by the National Science Foundation, while working at the Foundation. Any opinion, finding, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

7 REFERENCES

American Institute of Physics (2000). *Finding Aid to the James A. Van Allen Papers*, 1938-1990. Retrieved January 12, 2009 from the World Wide Web: <u>http://www.aip.org/history/ead/19990077.html</u>.

Berkner, L.V. (1955) Letter to H.H. Hess. October 27. Box 4, Institute of Theoretical Physics Folder. In E.H. Vestine Papers. Washington, D.C.: Library of Congress, Manuscripts Division.

Beynon, W.J.G. (1975) U.R.S.I. and the early history of the ionosphere. *Philosophical Transactions of the Royal Society of London: Series A, Mathematical and Physical Sciences* 280, 47-55.

Bullis, H. (1973) *The Political Legacy of the International Geophysical Year*. Washington, D.C.: U.S. Government Printing Office.

CSAGI Guide to World Data Centers (1959). In Annals of the International Geophysical Year, Vol. 7, 139-374. New York: Pergamon Press.

Chapman, S. (1955a) Letter to M.A. Tuve, January 8. Box 53, Folder 103, Data Processing. In Sydney Chapman Papers. Fairbanks: University of Alaska Fairbanks, Elmer Rasmuson Library, Archives.

Chapman, S. (1955b) Letter to R.J. Seeger, February 10. Box 4, Institute of Theoretical Physics Folder. In E.H. Vestine Papers. Washington, D.C.: Library of Congress, Manuscripts Division.

Chapman, S. (1955c) Letter to E.H. Vestine, October 24. Box 4, Institute of Theoretical Physics Folder, in E.H. Vestine Papers. Washington, D.C.: Library of Congress, Manuscripts Division.

Chapman, S. (1960) From polar years to geophysical year. Studia geophysica et geodaetica 4, 313-324.

Day, A. (1959) Memorandum to IGY WDCs and Permanent Services. June 9. Series 8.1. World Data Centers and Data Processing. WCD-A: General Correspondence, Jan 1958 – June 1959. In U.S. National Committee for the IGY. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

England, J.M. (1983) A Patron for Pure Science. Washington, D.C.: National Science Foundation.

Gerson, N.C. (1953) 1st USNC meeting, 27 March 1953, Box 8, Folder 1, NC Gerson Papers. Washington, D.C.: Library of Congress, Manuscripts Division.

Gerson, N.C. (1956) Letter to J. Kaplan, November 23. Series 8.1, World Data Centers and Data Processing. Data Center, 1956-1957 File. In U.S. National Committee for the IGY. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

Good, G.A. (2000). Biography of Sydney Chapman. In *Finding Aid to the Sydney Chapman Papers*. Alaska and Polar Regions Collections, Elmer E. Rasmuson Library, University of Alaska Fairbanks. Retrieved January 12, 2009 from the World Wide Web: <u>http://www.aip.org/history/ead/19990060_content.html</u>.

Hart, P.J. (1960). Memorandum to Directors, World Data Center A. March 2. Series 8.1, World Data Centers and Data Processing, WDC-A: General Correspondence, Jan-Mar 1960. In U.S. National Committee for the IGY. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

Jones, H.S. (1959) The inception and development of the International Geophysical Year. In *Annals of the International Geophysical Year*, Vol. 1, 383-413. New York: Pergamon Press.

Kaplan, J. (1955) Letter to W.A. Wildhack and others, April 15. Series 8.1, World Data Centers and Data Processing, Committee on Data Processing, Correspondence, 1954-1956. In U.S. National Committee for the IGY. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

Needell, A. (2000) *Science, Cold War, and the American State: Lloyd V. Berkner and the Balance of Professional Ideals.* Washington, D.C.: Smithsonian and Harwood Academic.

Nicolet, M. (1984) The International Geophysical Year (1957-1958): Great achievements and minor obstacles. *GeoJournal* 8(4), 303-320.

Ruttenberg, S. and Rishbeth, H. (1994) World data centres – past, present and future. *Journal of Atmospheric and Terrestrial Physics* 56(7), 865-870.

Shapley, A.H. (1956) Letter to J. Kaplan, July 9. Series 8.1, World Data Centers and Data Processing. Data Center, 1956-1957 File. In U.S. National Committee for the IGY. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

Sullivan, W. (1961) Assault on the Unknown: The International Geophysical Year. New York: McGraw-Hill.

Tuve, M.A. (1955) Letter to S. Chapman, January 20. Box 53, Folder 103, Data Processing. In Sydney Chapman Papers. Fairbanks, AK: University of Alaska, Elmer Rasmuson Library, Archives.

U.S. National Committee for the IGY (1952-1953) Organization of USNC, 1952, and USNC Correspondence, 1953. Series 1, U.S. National Committee. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

U.S. National Committee for the IGY (1954-1959) Series 8.1, World Data Centers and Data Processing. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

U.S. National Committee for the IGY (1957). Memorandum on Primary Archives of the USNC-IGY World Data Center, January 23, Enclosure A: Statute of the World Centre in the USSR. Series 8.1, World Data Centers and Data Processing. Data Center, 1956-1957 File. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

U.S. National Committee for the IGY (1960a). Ad Hoc Committee on Geophysical Data. Report. June. Series 8.1 World Data Centers and Data Processing. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

U.S. National Committee for the IGY (1960b) Executive Committee. Transcript of 41st Meeting. May 6. Series 2.4, USNC Executive Committee Meetings. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

Van Allen, J.A. (1997) Interview with B. Shoemaker, November 18, 1997. Transcript, Oral History Collection, Ohio State University, Columbus.

Van Allen, J.A. (1998) Genesis of the International Geophysical Year. The Polar Times 2(11), 5.

Vestine, E.H. (1955-1956) Institute of Theoretical Physics Folder. Box 4, Vestine Papers. Washington, D.C.: Library of Congress, Manuscripts.

Vestine, E.H. (1956) Handwritten note to R. Peavey (probably written in late 1956). Professional Correspondence, 1940-1958. Box 1. Vestine Papers. Washington, D.C.: Library of Congress, Manuscripts.

Vestine, E.H. and Schilling, G.F. (1956) Final Report: Recommendations for the Establishment of the United States IGY World Data Center, December 1. Series 8.1, World Data Centers and Data Processing. Data Center, 1956-1957 File. In U.S. National Committee for the IGY. Washington, D.C.: National Academies of Science, Archives, International Geophysical Year Collection.

(Article history: Received 7 April 2009, Accepted11 February 2010, Available online 20 February 2010)